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Corrosion Control Treatment using Orthophosphate

The Lead and Copper Rule (LCR) was promulgated in 1991 by the United States Environmental Protection Agency (USEPA) and mandated that all Community Water Systems (CWS) reduce their levels of lead and copper at customer taps by using Corrosion Control Treatment (CCT)1. CCT is of vital importance in the water treatment process due to the health effects associated with lead exposure. Studies have shown that lead can result in behavior and learning problems, low IQ, and slowed growth in children, reduced fetus growth and premature birth in pregnant women, and cardiovascular problems and reproducibility issues in adults2,3. These health effects have made lead in drinking water a prominent topic for water treatment, as a lot of old plumbing inside of homes contains lead that could leach into the drinking water. CCT helps to prevent this lead from making its way into the bulk water. There are several ways of implementing CCT, including elevated pH and steady free chlorine residual, dosing with polyphosphate, or dosing with orthophosphate (o-PO4). Of those options, the most popular as of this writing is the use of o-PO4.

The implementation of CCT via dosing o-PO4 has been shown by many studies to reduce the amount of lead, and other metals, that can leach in to the bulk water from the pipe materials by forming a protective seal around the pipe3. This technique is especially useful to utilities who use chloramines as a disinfectant. Chloramines, unlike free chlorine, do not have the oxidation-reduction potential required to convert lead from the unstable, soluble form of lead (Pb2+) to the stable, insoluble form (Pb4+). As a result, lead is unstable in chloramine systems that do not use some other form of corrosion control. When o-PO4 is added to the water, the lead pipes react with the o-PO4 to form a very stable scale consisting of hydroxypyromorphite and/or chloropyromorphite3. These compounds are extremely stable and insoluble, resulting in a significant decrease in lead release from lead-containing pipes.

Similar to many other chemical treatment methods in the water treatment process, dosing o-PO4 follows a trend of diminishing return. This means that a utility cannot expect the same amount of reduction in lead levels by increasing o-PO4 once they have already reached a certain dosing level. Theoretical models have shown that the optimal dosage of o-PO4 can range from 1 to 3 mg/L as P depending on the level of dissolved inorganic carbon3. While this is the optimal dose in theoretical models, every system is different and pipe loop studies should be performed to indicate whether o-PO4 is the correct CCT for their system and at what dose the o-PO4 is most effective.

CCT is an extremely important part of the water treatment process for drinking water and is something that should always be considered when making any changes in the water treatment process. The effects of not carefully implementing CCT can be disastrous (as seen most recently in Flint, MI). o-PO4 may prove to be the most effective method of CCT.

**References:**

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2. “Basic Information about Lead in Drinking Water.” *EPA*, Environmental Protection Agency, 23 Mar. 2018, www.epa.gov/ground-water-and-drinking-water/basic-information-about-lead-drinking-water#health.
3. Edzwald, James K. *Water Quality & Treatment: a Handbook on Drinking Water*. 6th ed., McGraw-Hill, 2011. pg 2.39-2.40, 20.54-20.63